STATUS OF CERES CLOUD ALGORITHMS

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CERES STM T2, October 16, 2003

MAIN OBJECTIVES

- **Finalize Terra MODIS Edition 2 algorithm**
  - **Develop and implement changes & improvements**
    Polar mask poor at night & twilight
- **Select GMAO GEOS 4 or ECMWF**

Polar Mask Improvements

1. Daytime Polar:

- **reduced false clouds over super cold ice surface (Antarctica & Greenland).**
- **added thin Cirrus detection test.**
- **added low clouds detection for high SZA.**
- **included Tskin test for detecting clear land and snow/ice surfaces.**

2. Twilight Polar:

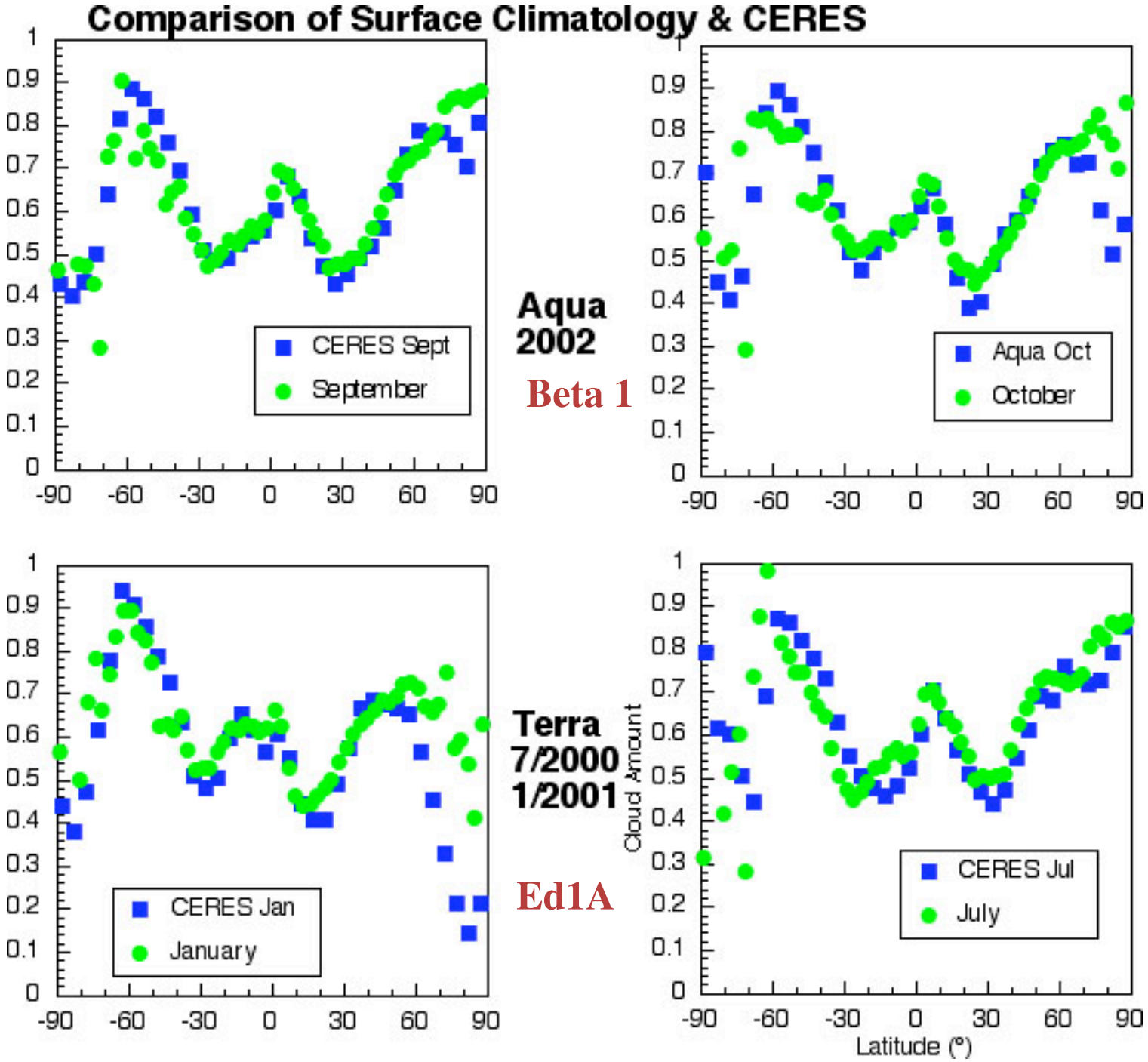
- **improved Terra & Aqua twilight detection using 1.6 (2.1), 0.6 and 3.7 μm reflectances**
- **reduced discontinuity across from day-to-twilight-to-night.**
- **separate cloud tests for super cold ice caps.**

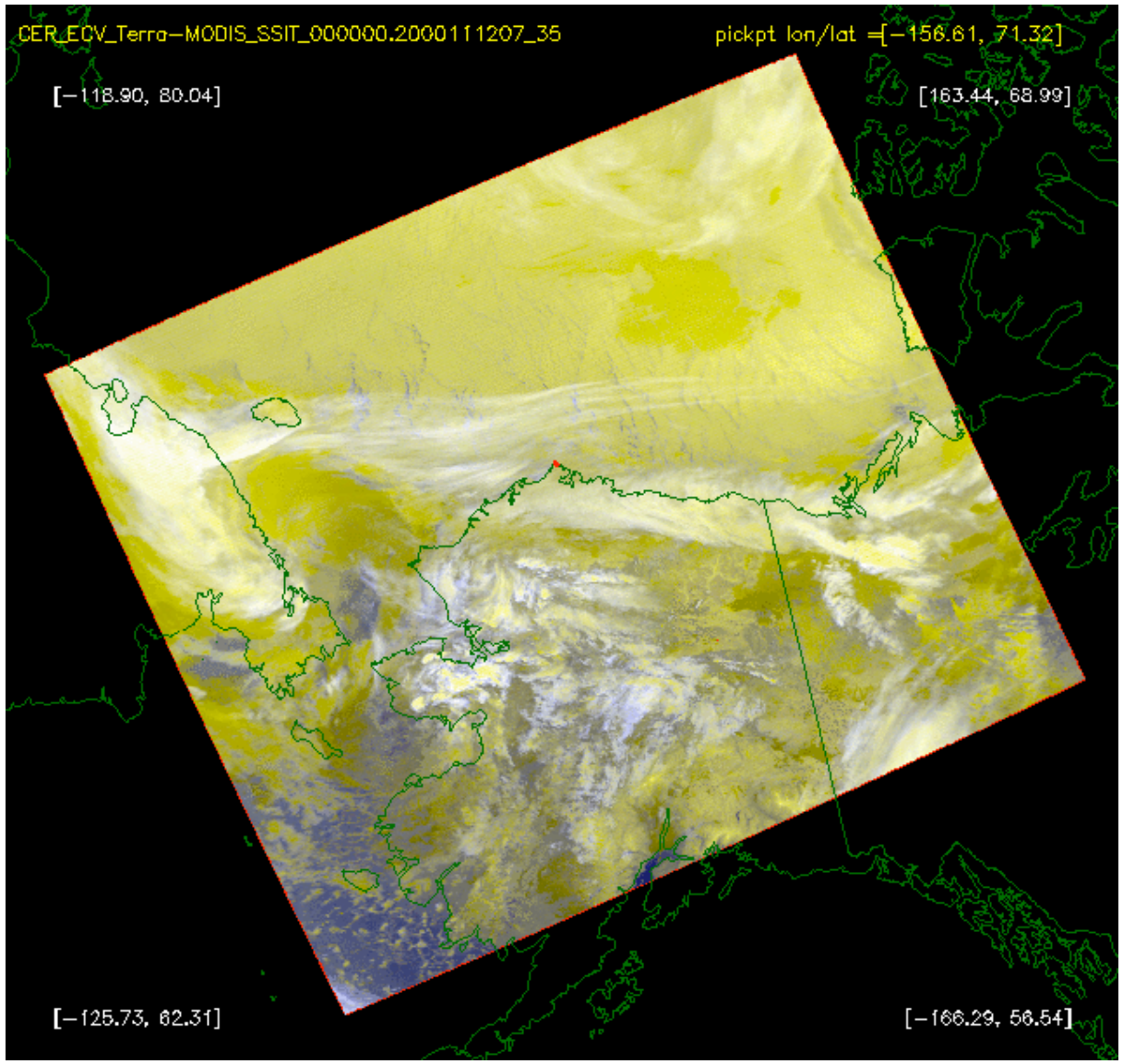
3. Nighttime Polar:

- **refined thresholds for low clouds, inversion clouds, snow/ice surface tests.**
- **added separate cloud detection tests over super cold plateau to prevent call to ice cap clouds. (including T6.7 - T11, T8.5 - T11 tests)**
- **better clear land detection using T6.7 - T11 tests etc.**
- **extended polar nighttime tests to non-polar regions where ancillary maps indicates snow/ice**

4. Eliminated TBDs pixels in both daytime and nighttime polar masks by adding mini-masks.

(including coastal regions where snow/ice maps are uncertain)


Comparison of Surface Climatology & CERES
CERES Sept
September
Aqua
2002
Beta 1
Aqua Oct
October
CERES Jan
January
Terra
7/2000
1/2001
Ed1A
CERES Jul
July
Cloud Amount
Latitude (°)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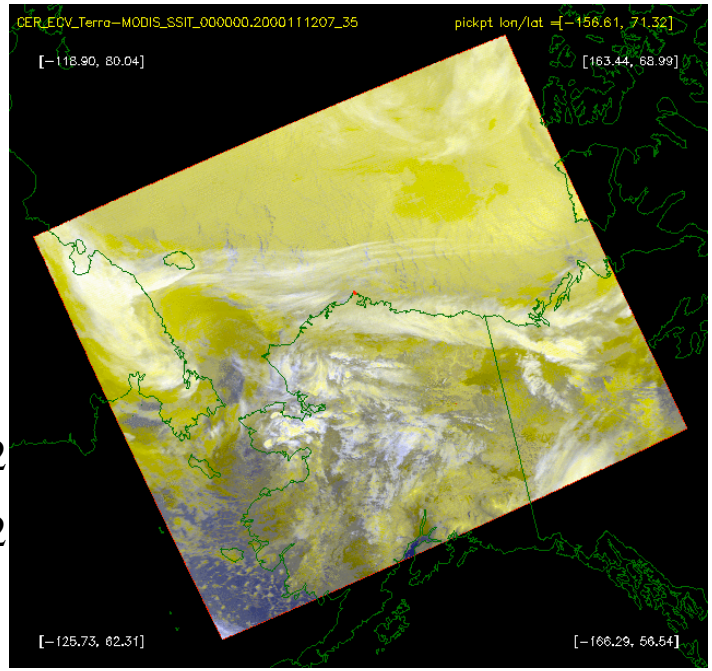
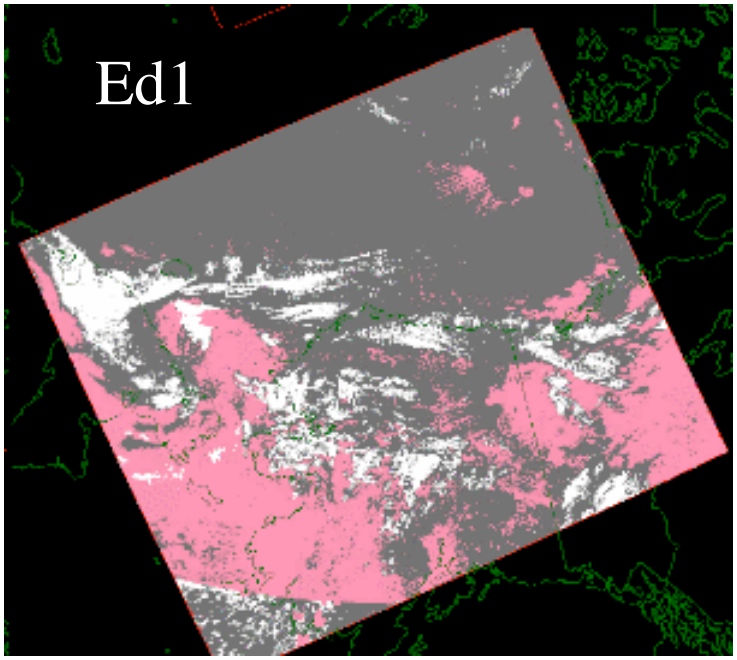
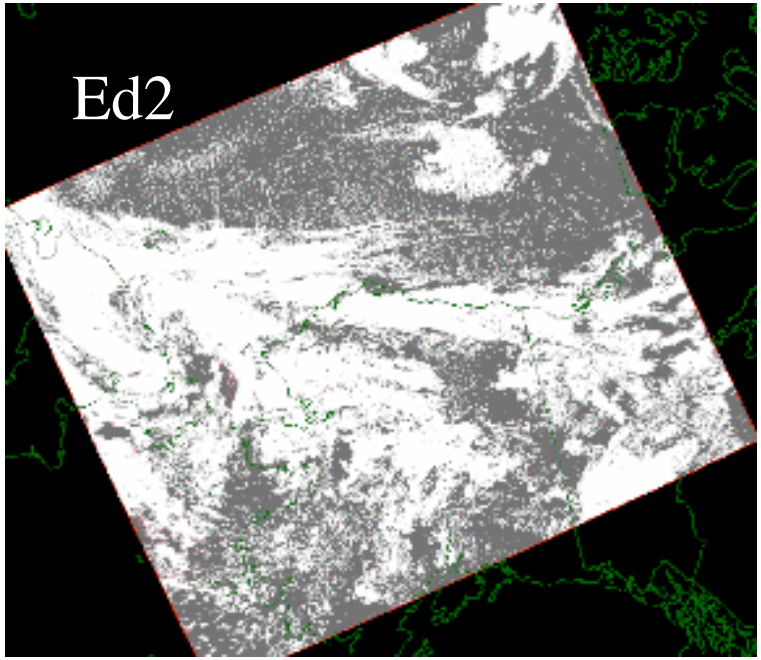
[163.44, 68.99]
[-125.73, 62.31]
[-166.29, 56.54]

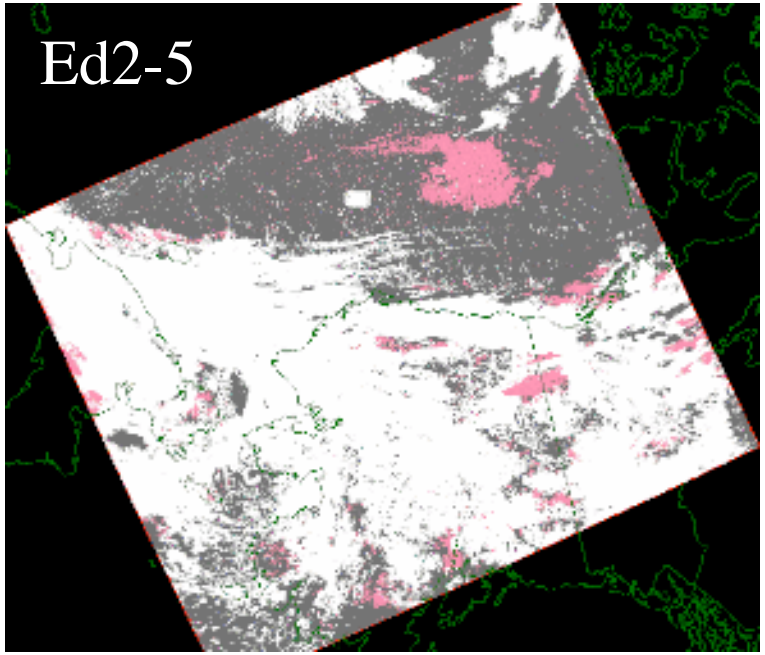
11/12/00
7 UTC

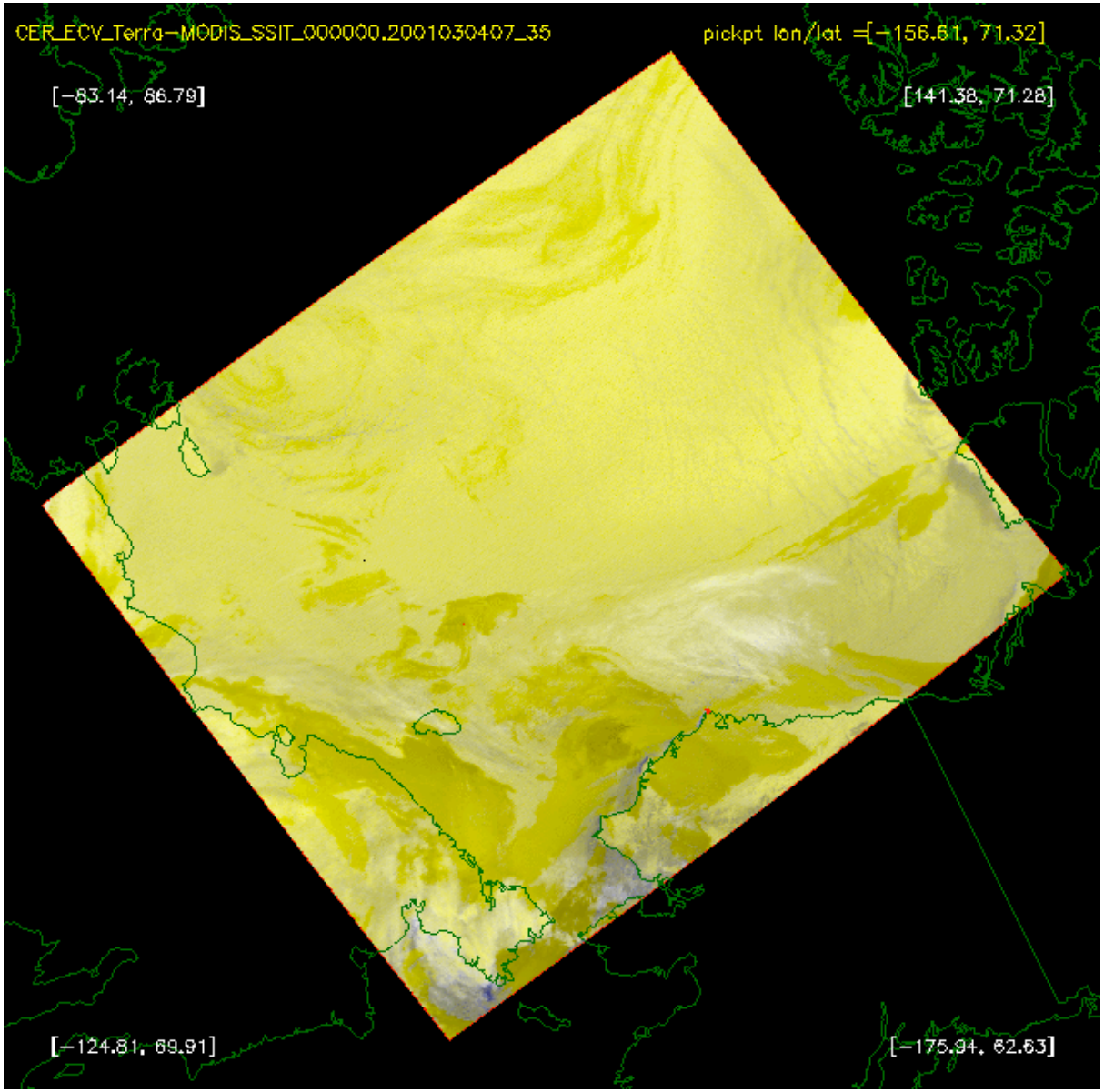
Ed1 -64 Wm^2
Ed2 -47 Wm^2







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[141.38, 71.28]
[-124.81, 69.91]
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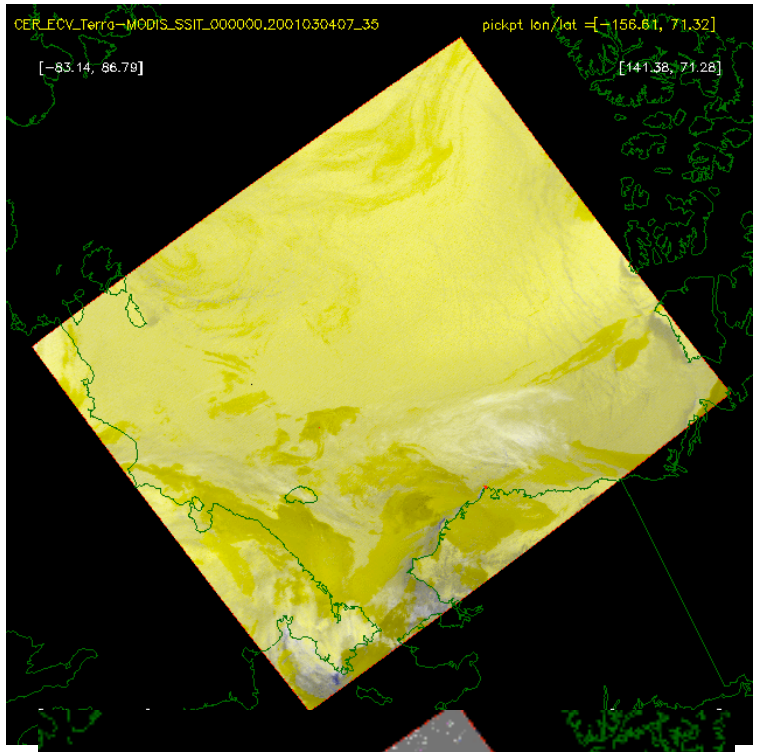
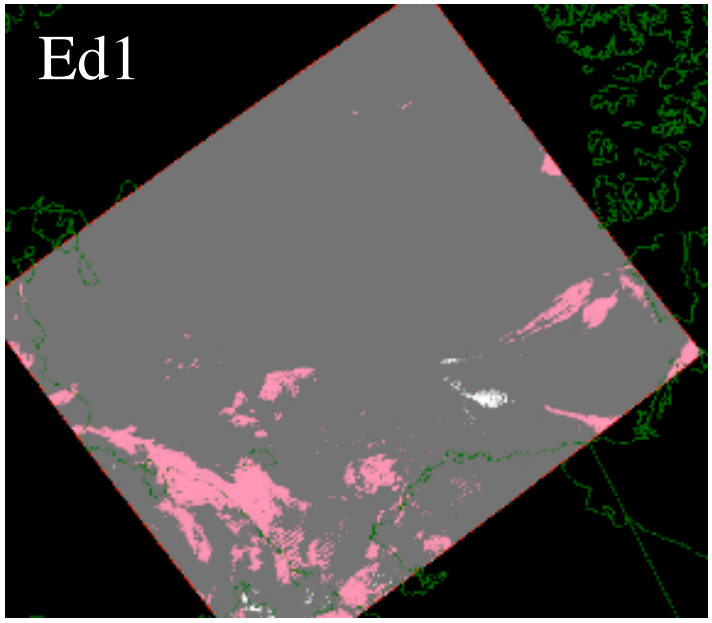
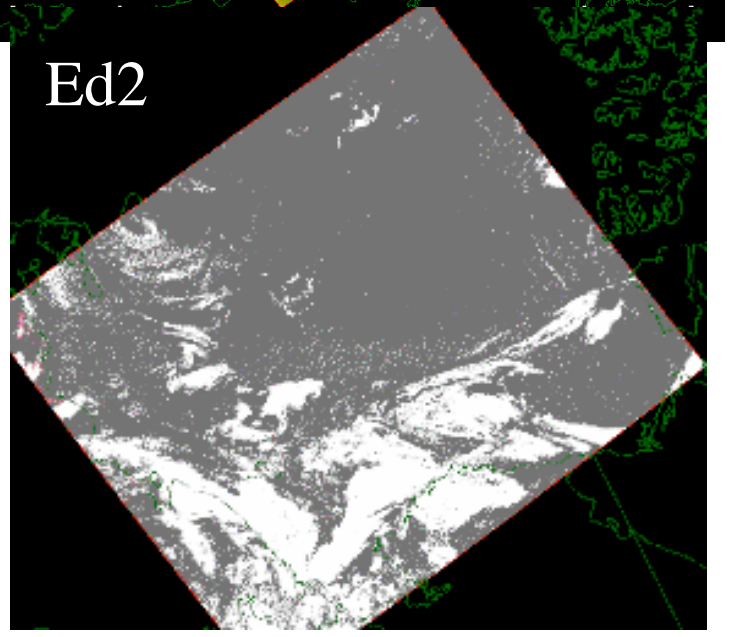
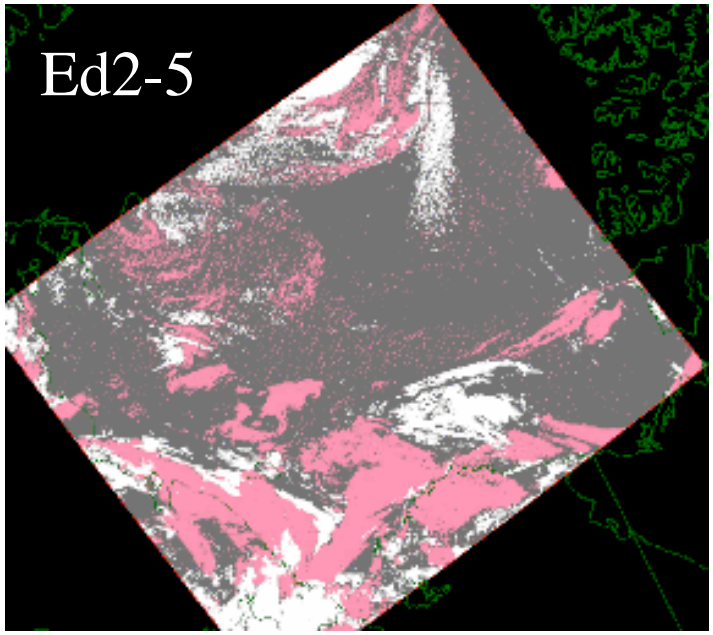
3/4/01 7UTC

Ed1 -65 Wm^2
Ed2 -15Wm^2

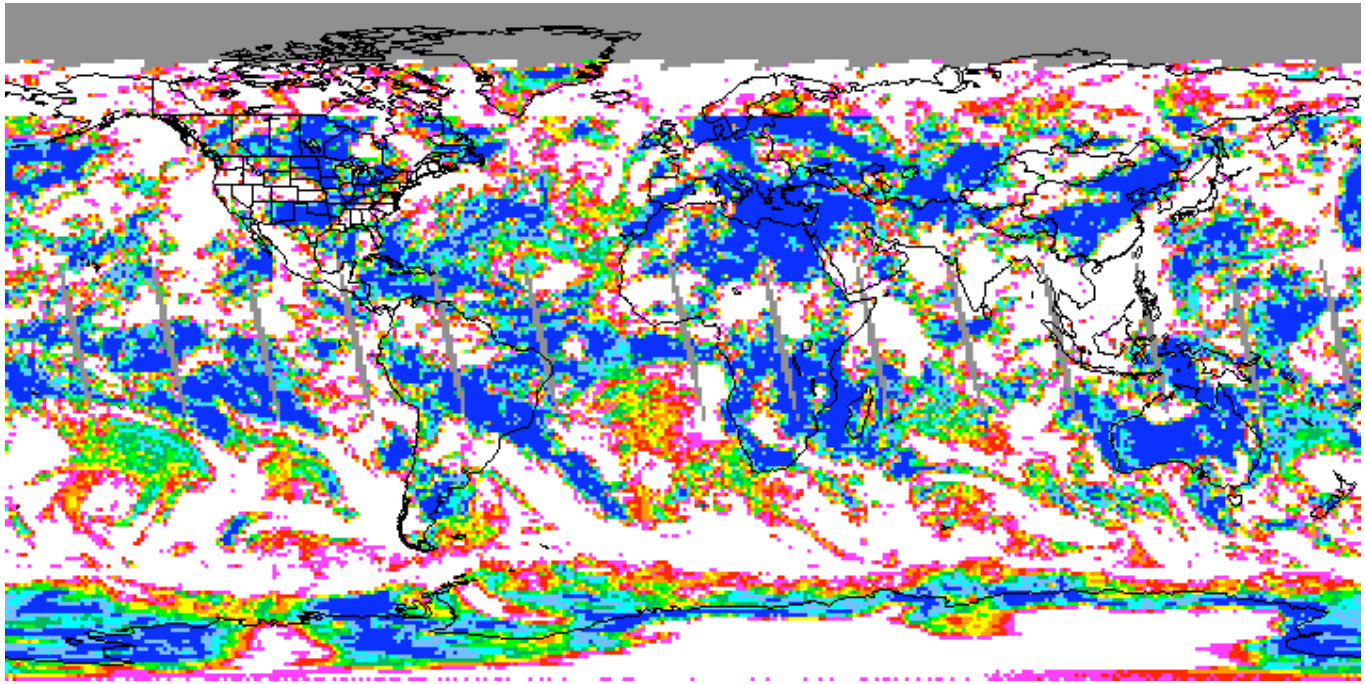








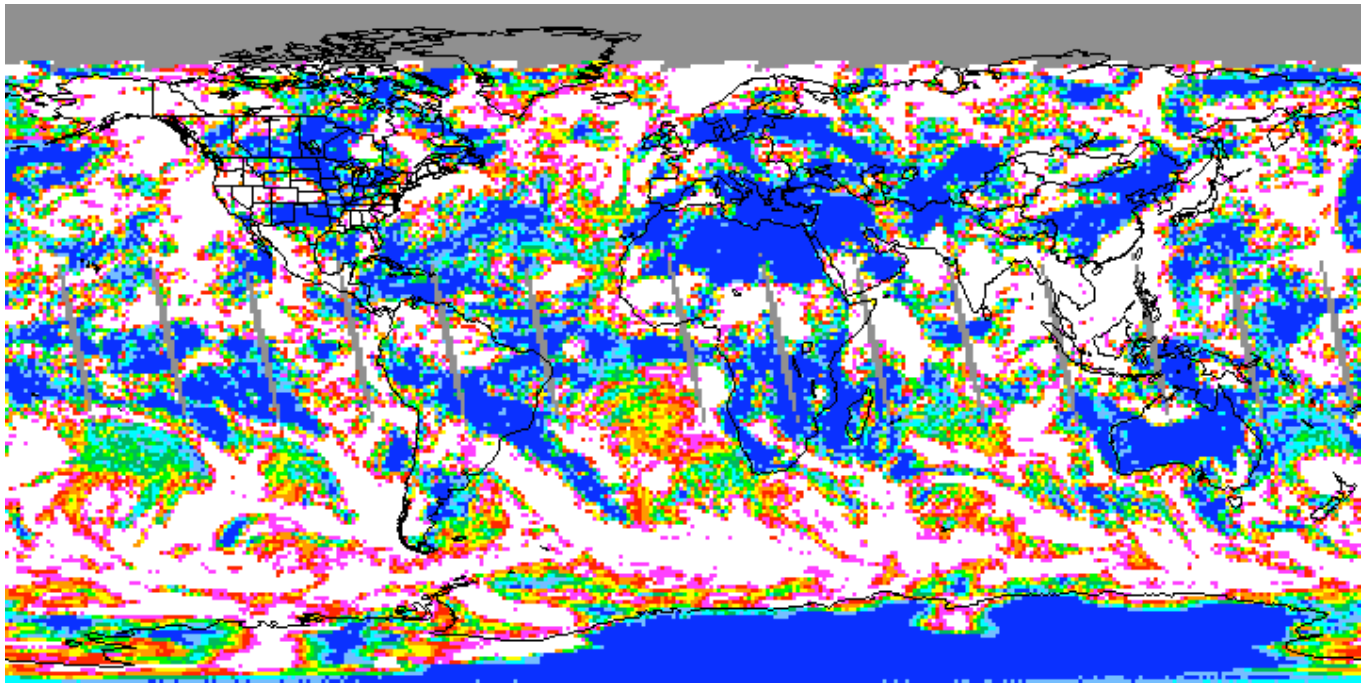
Ed1



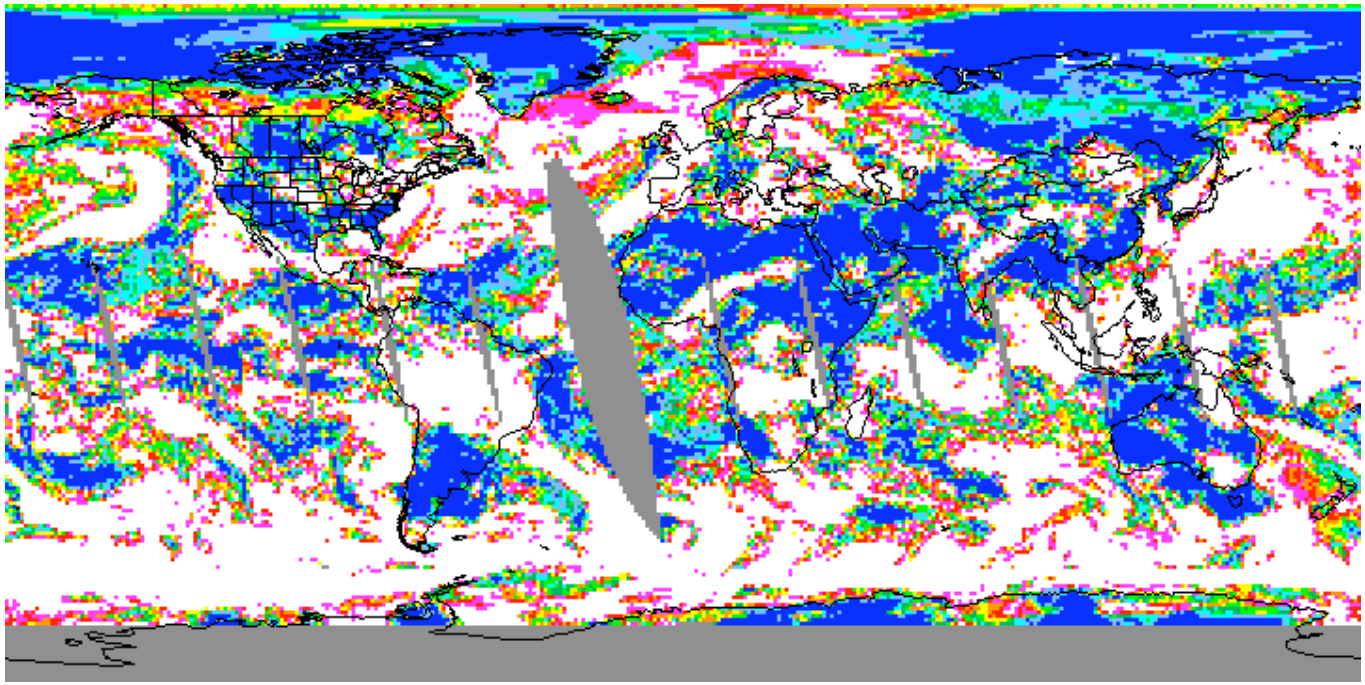
July 5

Night

Ed2



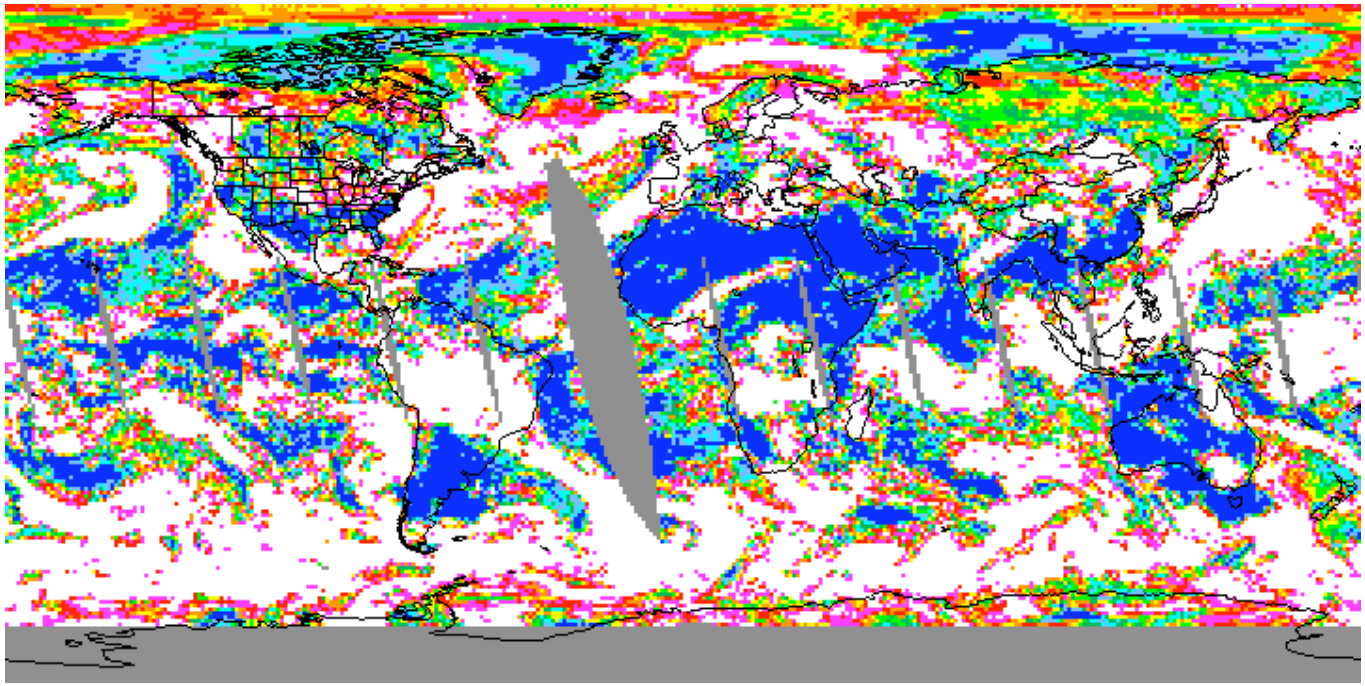
Ed1



Dec 31

Night

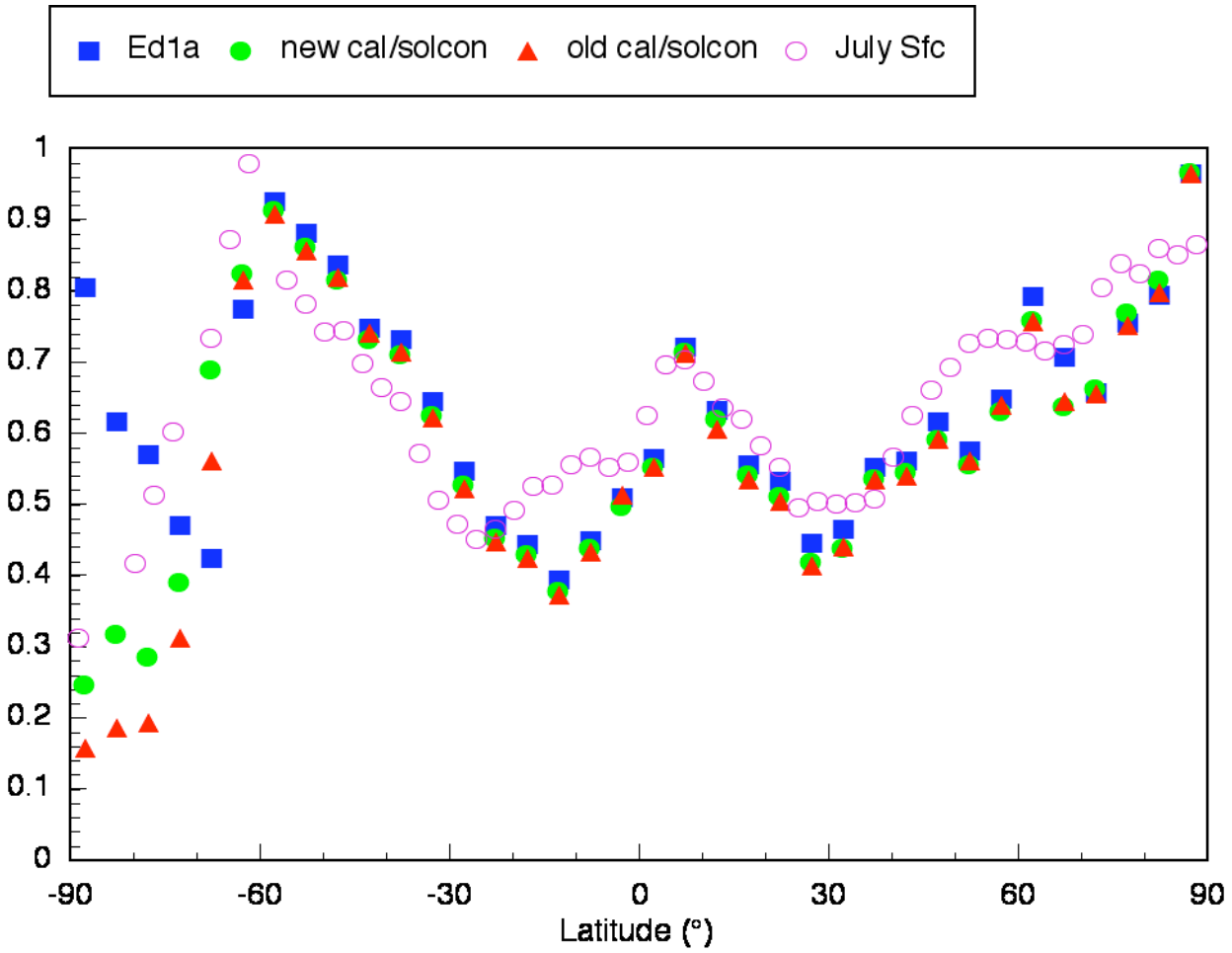
Ed2



July 5, 2001 Case

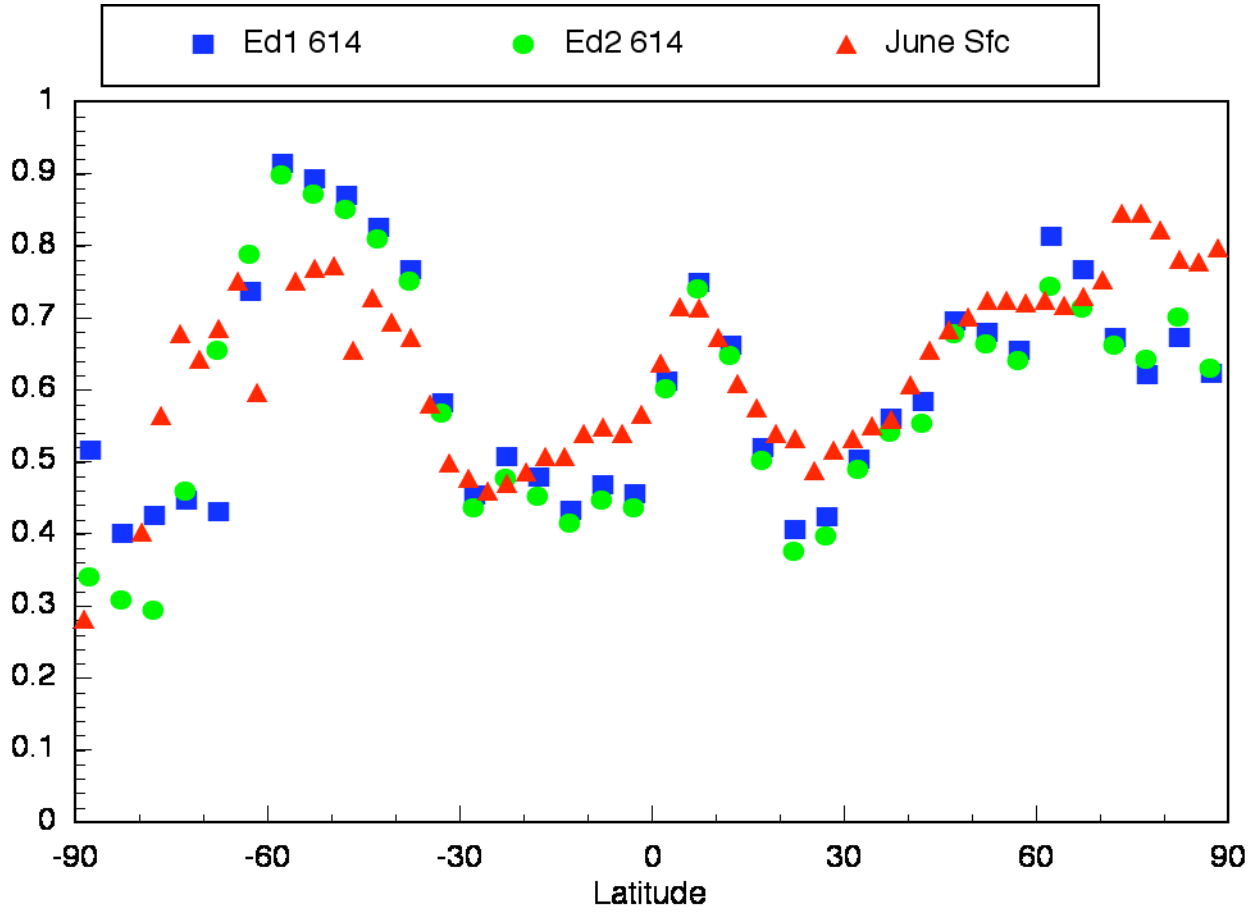
Decrease in Cld over Antarctica (big)

Small decrease elsewhere NP



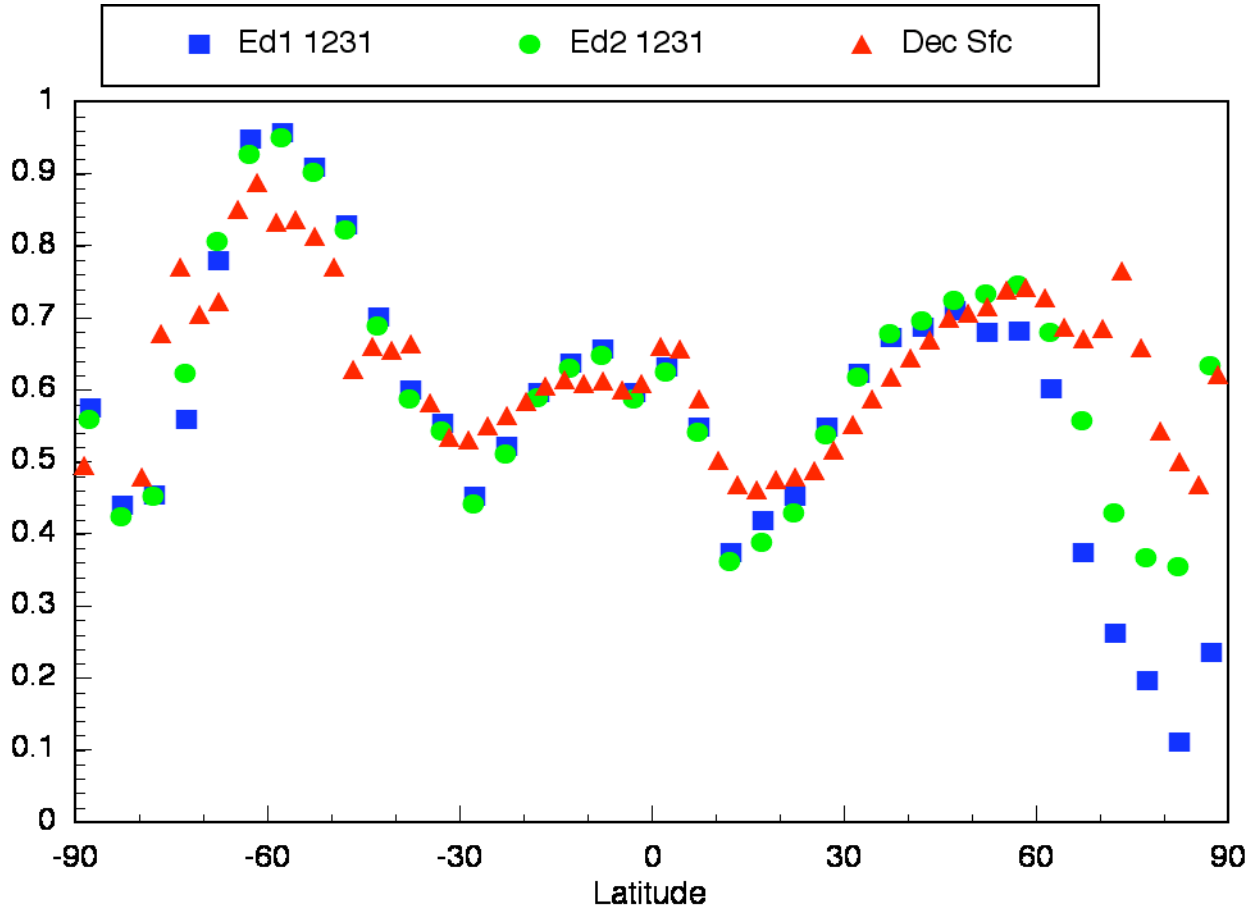
Calibration not source of non-polar decrease

June 14, 2001 Case



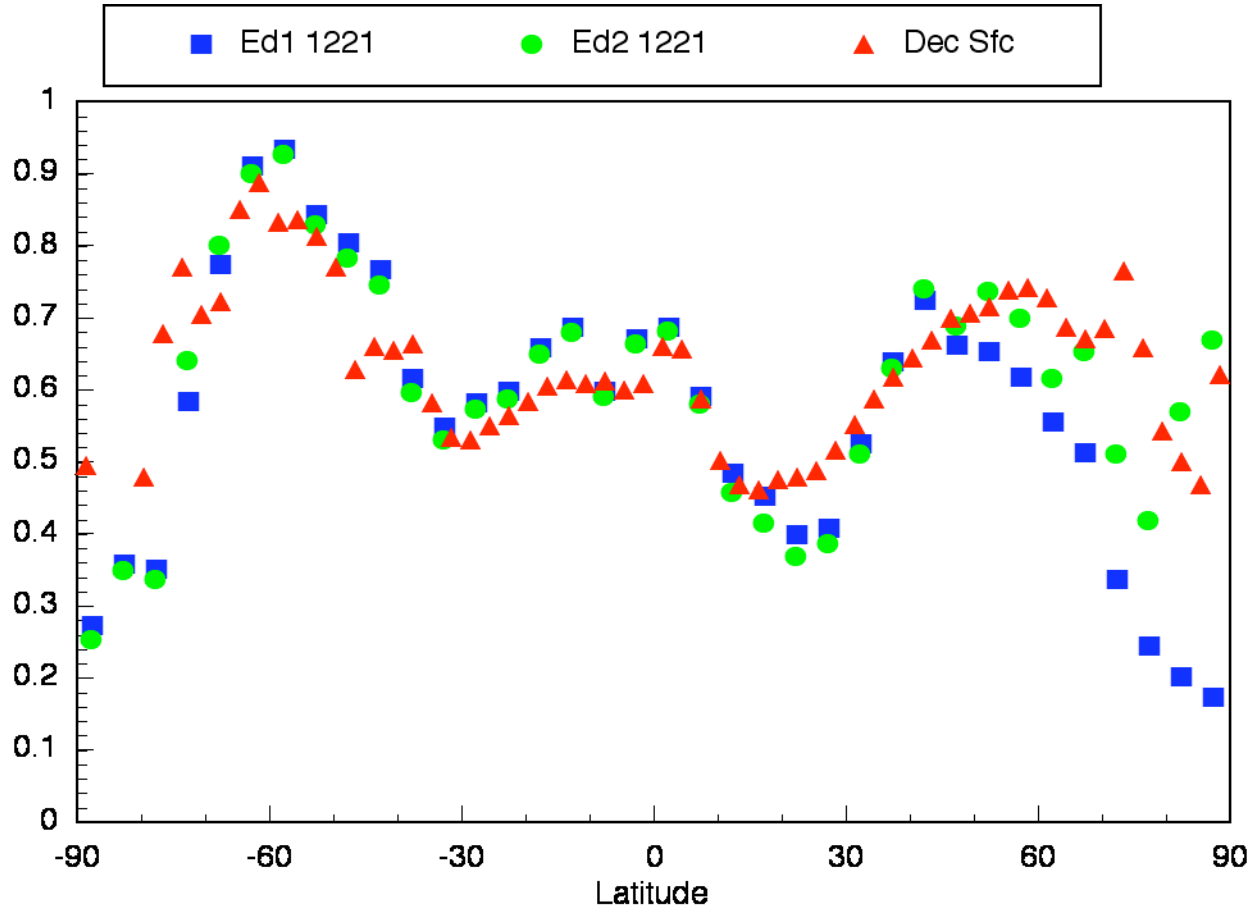
Antarctic values decreased, twilight better

Dec 31, 2000 Case

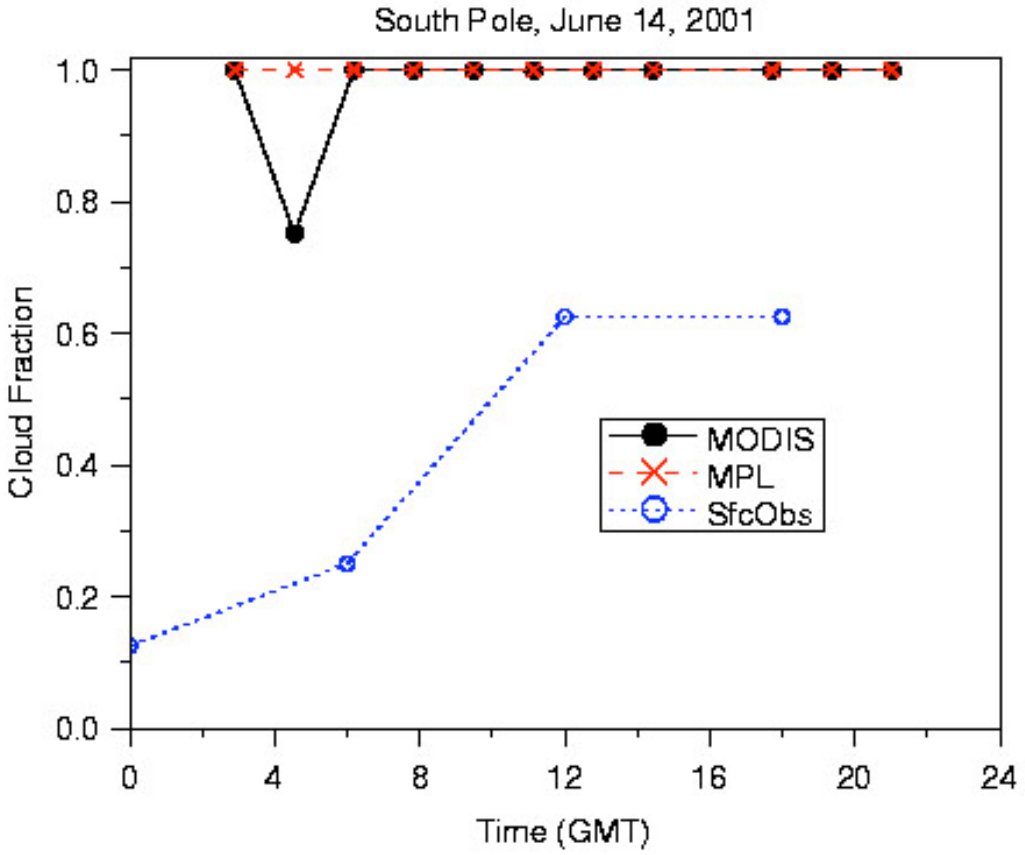


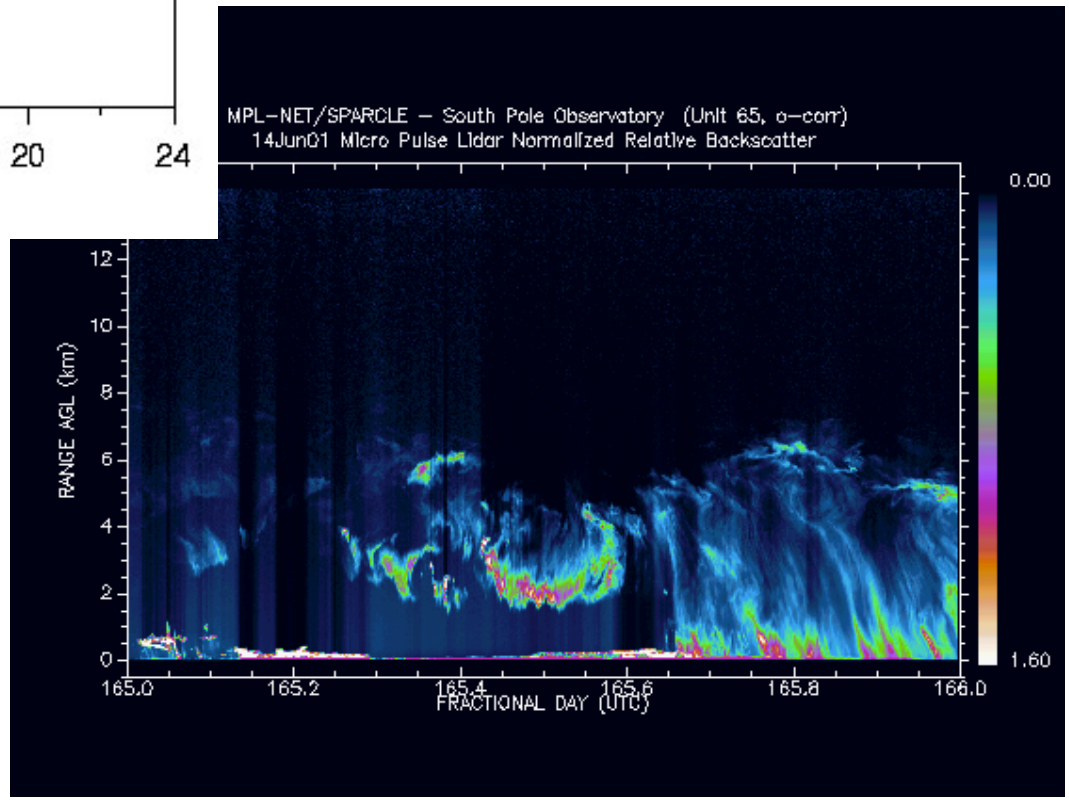
Increase in polar night, still < sfc

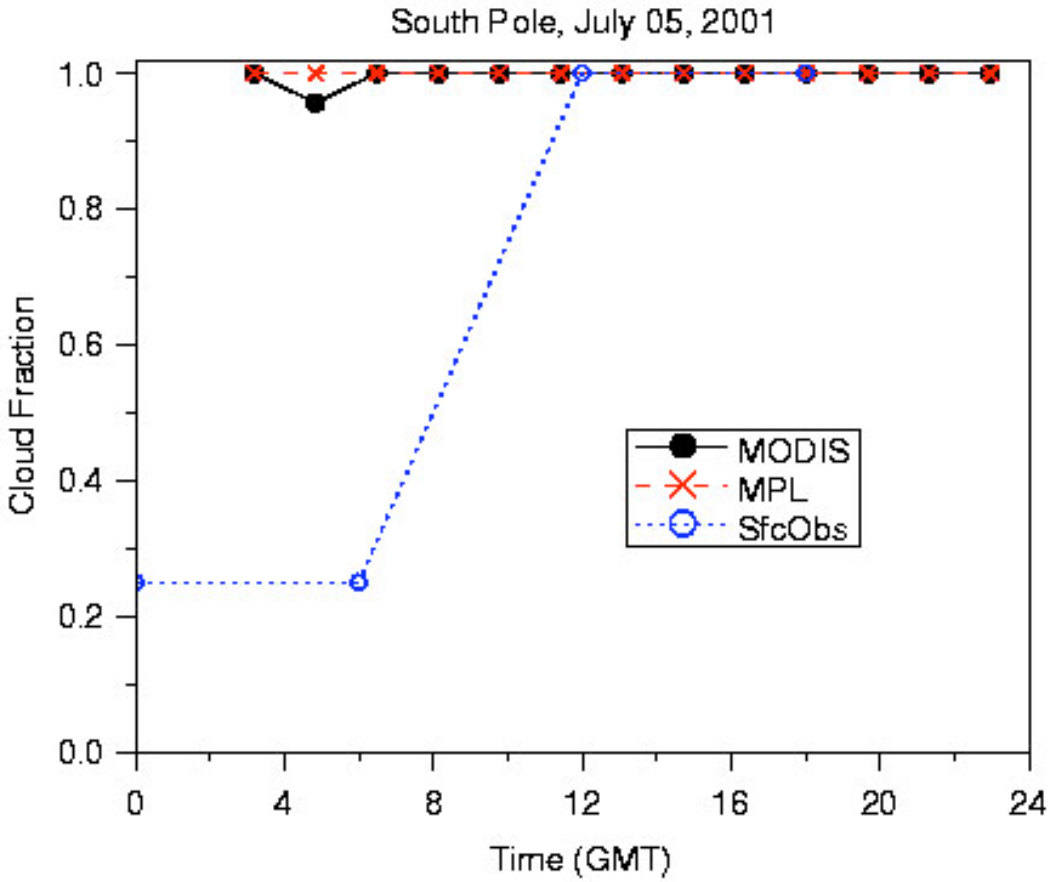
Dec 21, 2000 Case

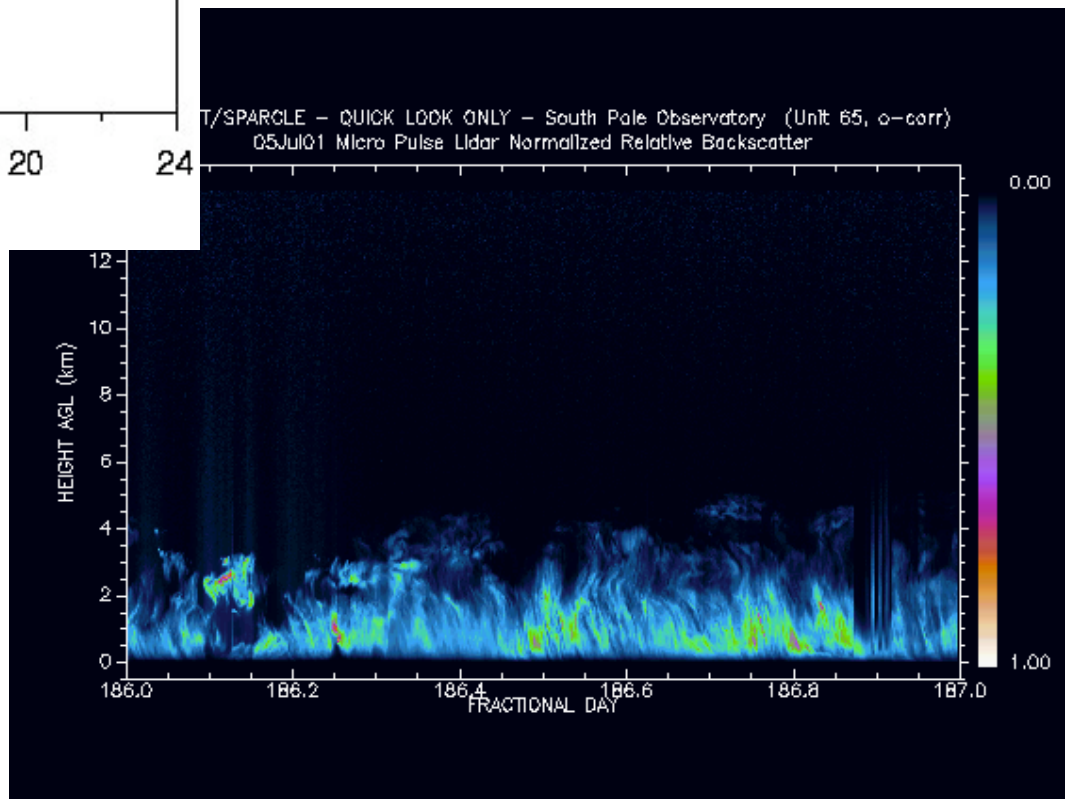


Increase in polar night, much closer to sfc


South Pole, June 14, 2001
Cloud Fraction
Time (GMT)
MODIS
MPL
SfcObs
0.0
0.2
0.4
0.6
0.8
1.0
0
4
8
12
16
20
24


MPL-NET/SPARCLE – South Pole Observatory (Unit 65, a-corr)
14Jun01 Micro Pulse Lidar Normalized Relative Backscatter
RANGE AGL (km)
FRACTIONAL DAY (UTC)
0.00
1.60
0
2
4
6
8
10
12
165.0
165.2
165.4
165.6
165.8
166.0

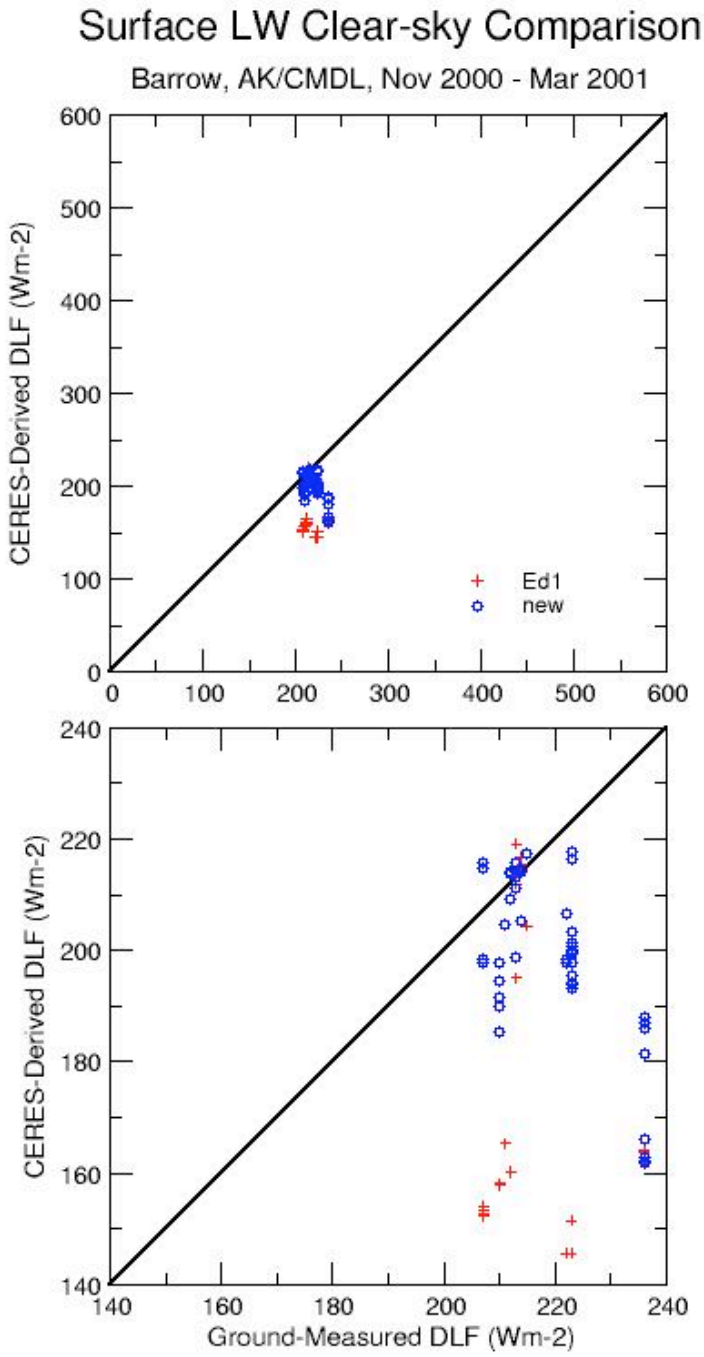

South Pole, July 05, 2001
Cloud Fraction
Time (GMT)
MODIS
MPL
SfcObs
0.0
0.2
0.4
0.6
0.8
1.0
0
4
8
12
16
20
24


T/SPARCLE – QUICK LOOK ONLY – South Pole Observatory (Unit 65, o-corr)
05Jul01 Micro Pulse Lidar Normalized Relative Backscatter
HEIGHT AGL (km)
FRACTIONAL DAY
0.00
1.00
0
2
4
6
8
10
12
186.0
186.2
186.4
186.6
186.8
187.0

New polar algorithm did not eliminate bias, it reduced it.

Ed1 = -60 Wm^2

Ed2 = -25 Wm^2



OTHER CHANGES

(1) Removed the overwrites from Welch mask when CERES mask returns TBD over polar region at daytime.

(2) Added the scheme of updating clear sky overhead sun albedo for each clear pixel for 1.6 um.

(3) Modified to only process every 2nd scanline and every 4th pixel (2x4).

(4) Polar region and coastal area where no microwave snow and ice information (about +/-50km of coasts)

overhead-sun albedo from CRH 0.6um map updated from day before used to compare with threshold for IGBP type & season.Threshold over ocean = average IGBP overhead sun albedo plus 3-sigma.
Threshold over one of land IGBP types is its average overhead sun albedo plus 2-sigma.
Exceeding this threshold over ocean sets sea-ice, over land sets snow.

(5) Removed non-unity surface emissivity from cloud mask's clear sky inputs (clear-sky brightness temperature for 11um and 12um) for non-polar regions. Surface emissivity still used for polar region cloud mask and for all cloud properties.

(6) Passed microwave sea-ice fraction into the cookie dough with each imager pixel.

(7) Over snow-ice non-elevated land, where an inversion cloud height was calculated from GOES lapse rate, the MOA skin temperature used in calculation was replaced by the daily averaged MOA air surface temperature.

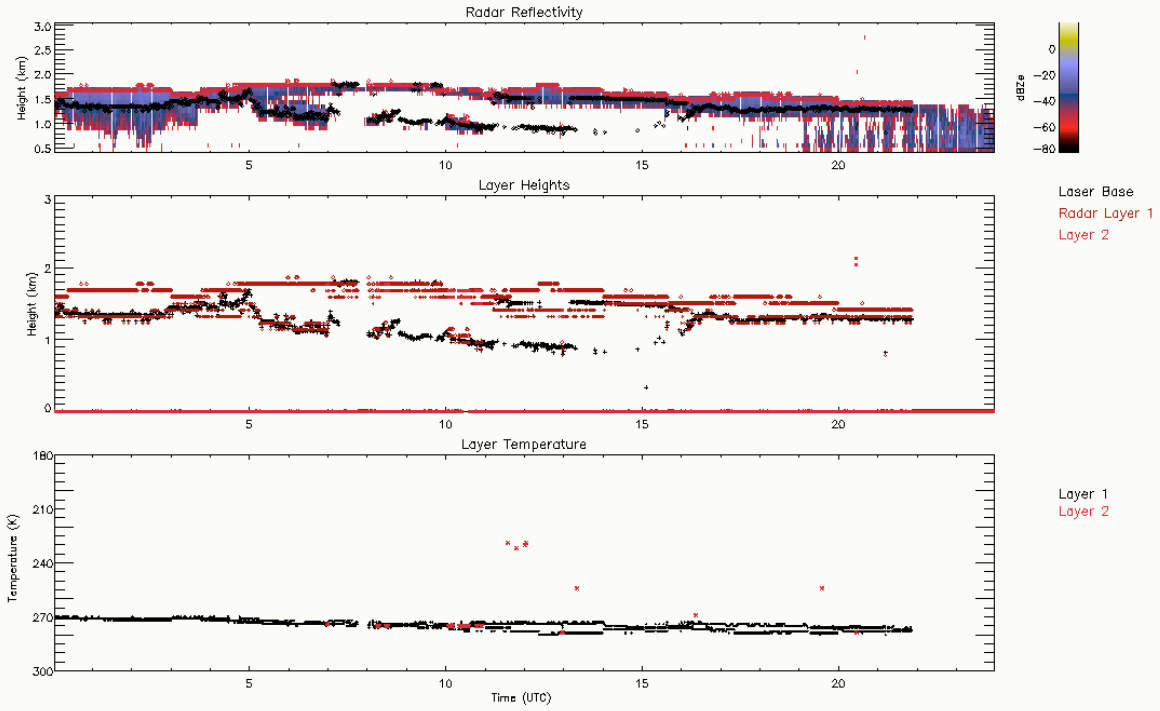
(8) Re-created 12 month of clear sky start-up map for 0.6um using clear sky updated Terra-MODIS Edition1A maps, where when IGBP = 15 (permanent snow) set overhead sun albedo = 0.89 (from snow-ice reflectance model).

(9) Added 4 more polar sites for Clouds validation sites

Summary

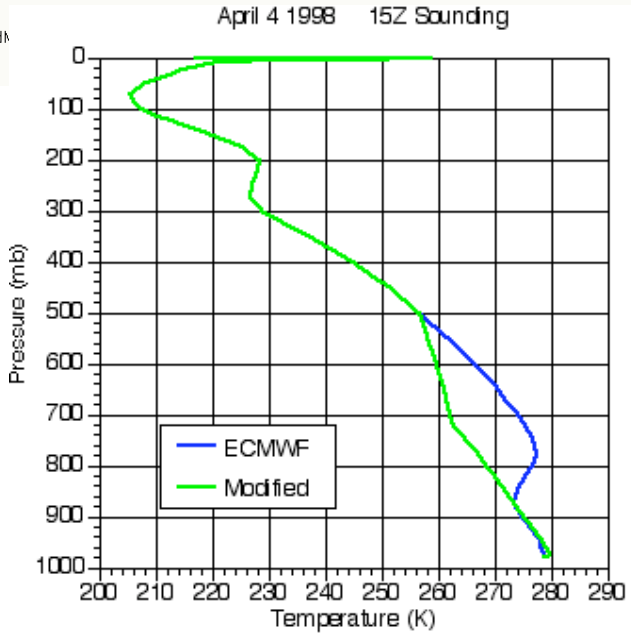
- Nocturnal clouds much improved over poles, but not perfect
  - Need more ground truth
- Twilight transition is better than before
- Decrease in nonpolar clouds due to inclusion of sfc emissivity in all aspects of the mask, only used in retrievals previously

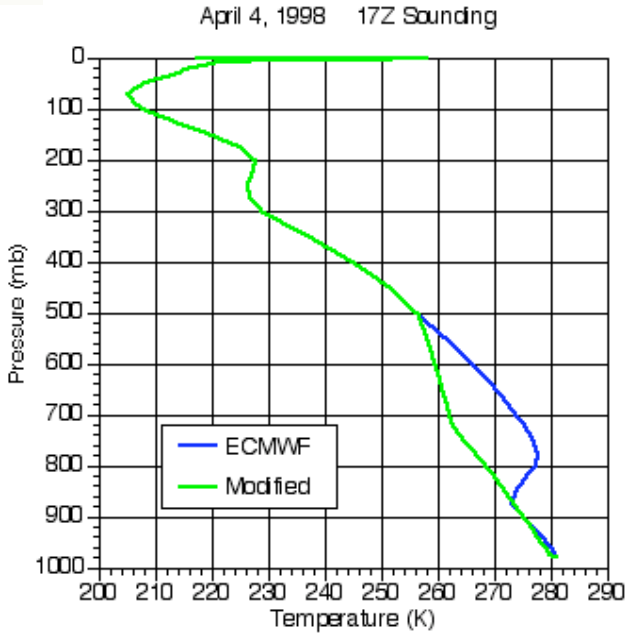
Cloud Height Change over Land



As documented in the proposal: low cloud heights over land were typically over-estimated because soundings missed inversion heights

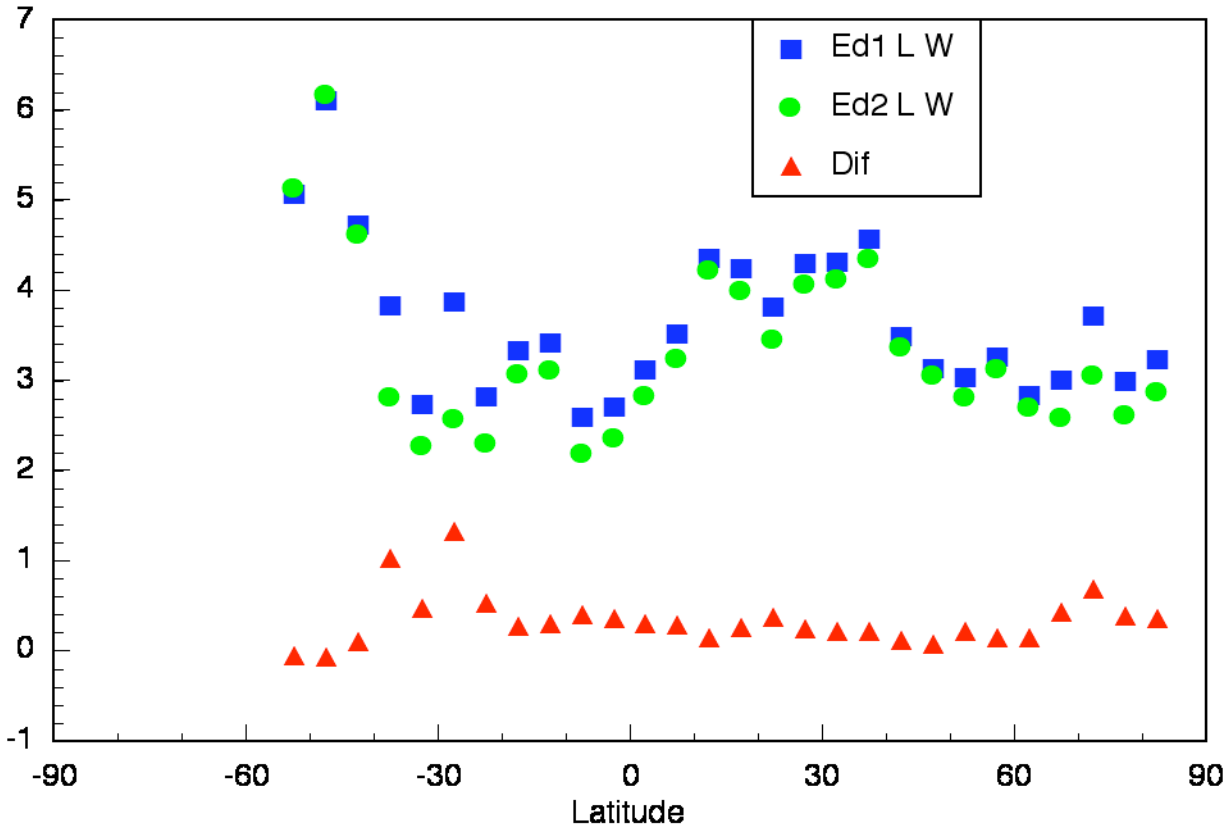
Solution: Use lapse rate method for lower layers in the same manner as over ocean. 24-hr mean surface air temperature becomes anchor of the lapse rate. Blend into soundings by 500 mb.





July 5, 2001 Water Cloud Height Comparison, Land

Cloud height , km



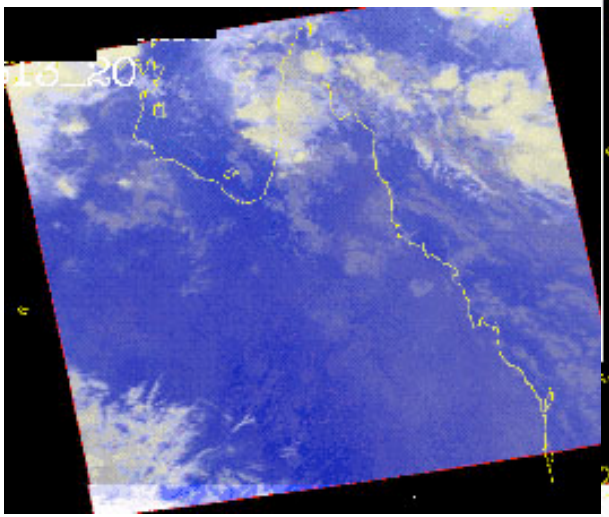
Mean difference ~ 0.3 km, no significant changes in other cloud heights

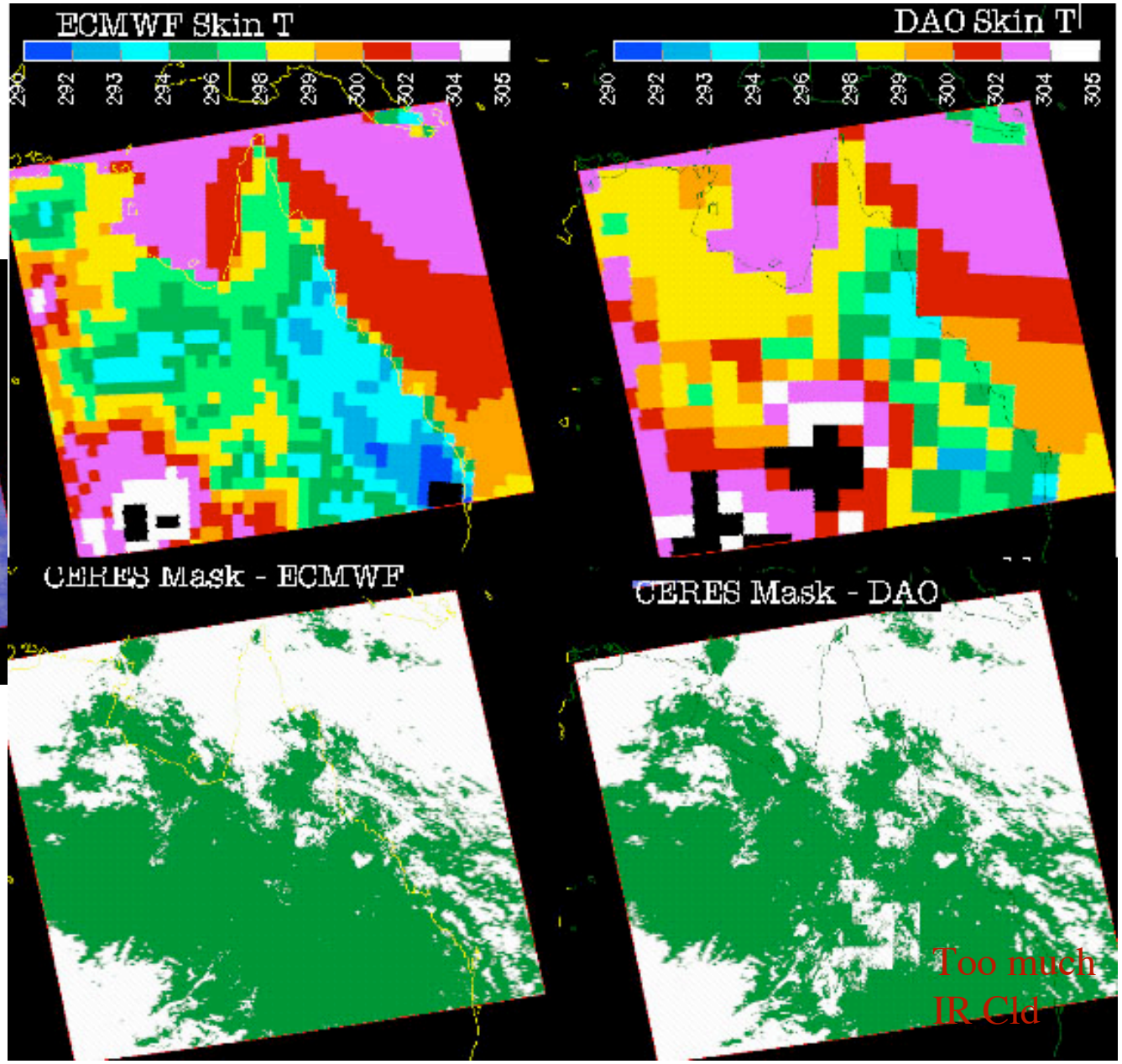
3.7-μm Solar Constant: To use or not to use

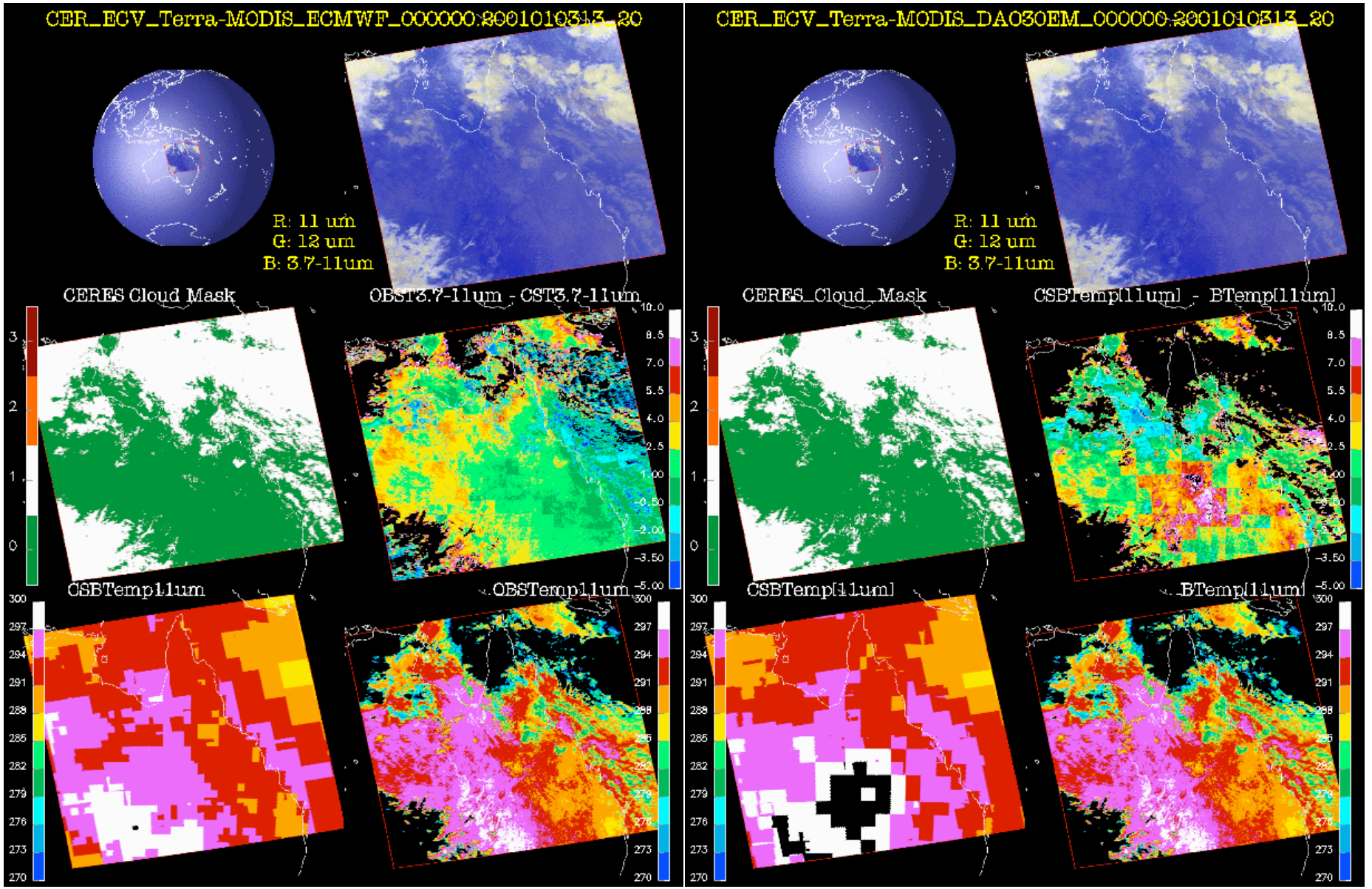
- MODIS Team increased the 3.7-μm channel with no comment
- Its use yields a 0.5-μm increase in re and a slightly larger increase in De -> more compatible with VIRS and Dong retrievals over SGP
- Do we implement it or not?

Australia, January 3, 2001, 1320 UTC

DAO surface too hot in center of desert

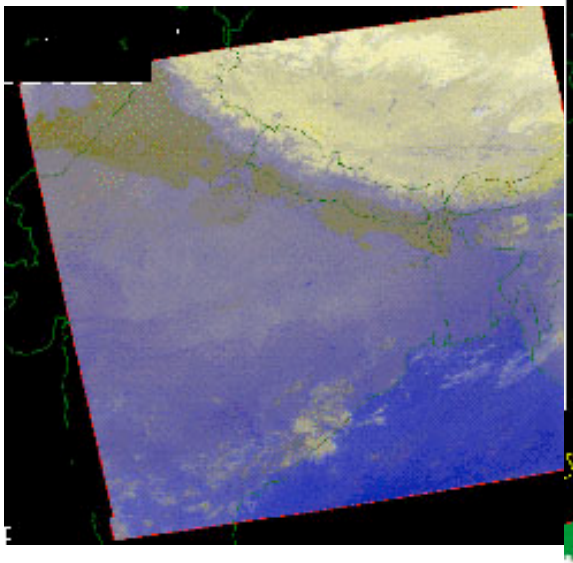


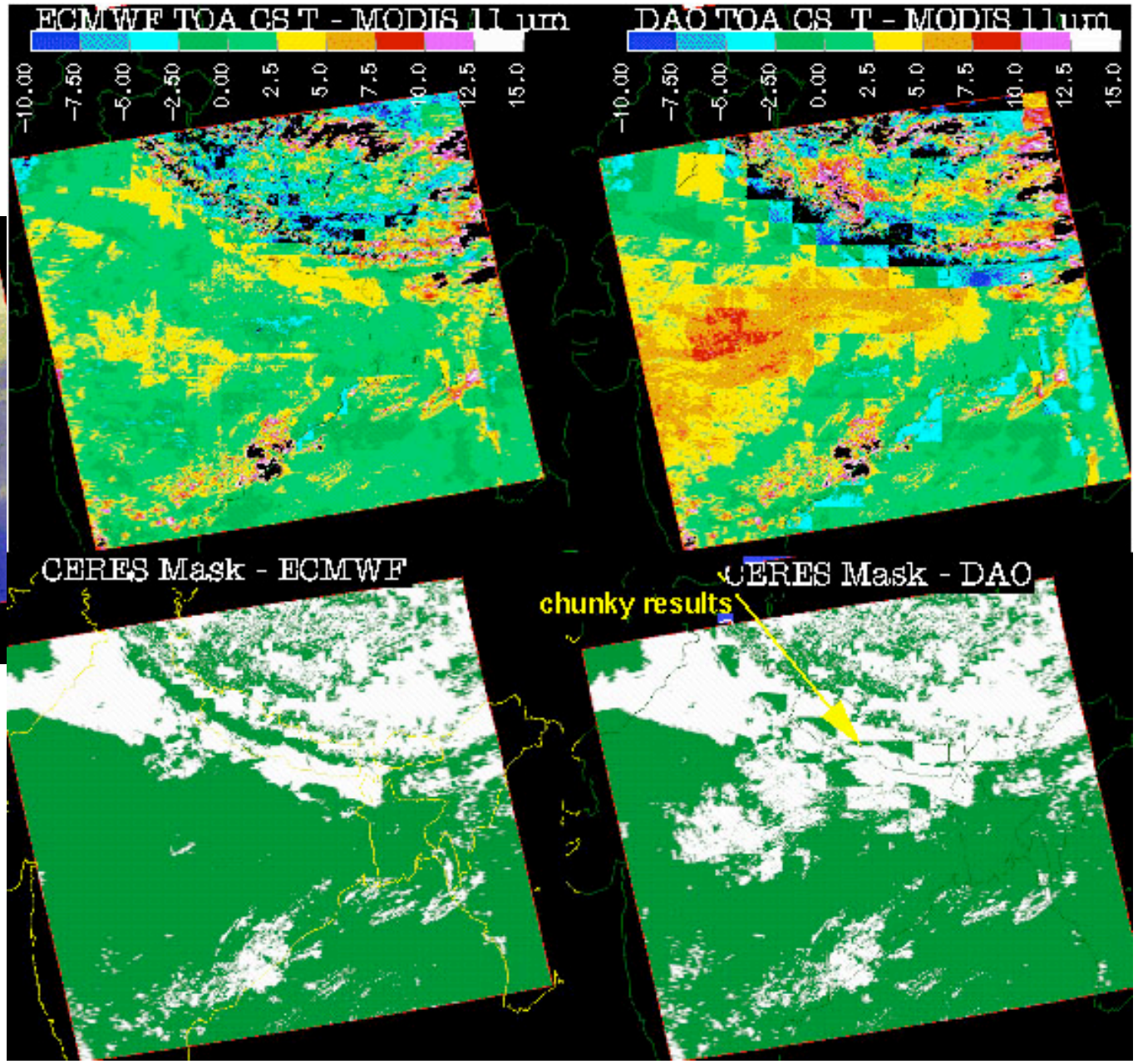



CER_ECV_Terra-MODIS_ECMWF_000000.20010103l3_20
R: 11 um
G: 12 um
B: 3.7-11um
CERES Cloud Mask
OBS3.7-11um - CST3.7-11um
CSBTemp11um
OBSTemp11um
CER_ECV_Terra-MODIS_DAO30EM_000000.20010103l3_20
R: 11 um
G: 12 um
B: 3.7-11um
CERES_Cloud_Mask
CSBTemp[11um] - BTemp[11um]
CSBTemp[11um]
BTemp[11um]

India, January 3, 2001, 1650 UTC

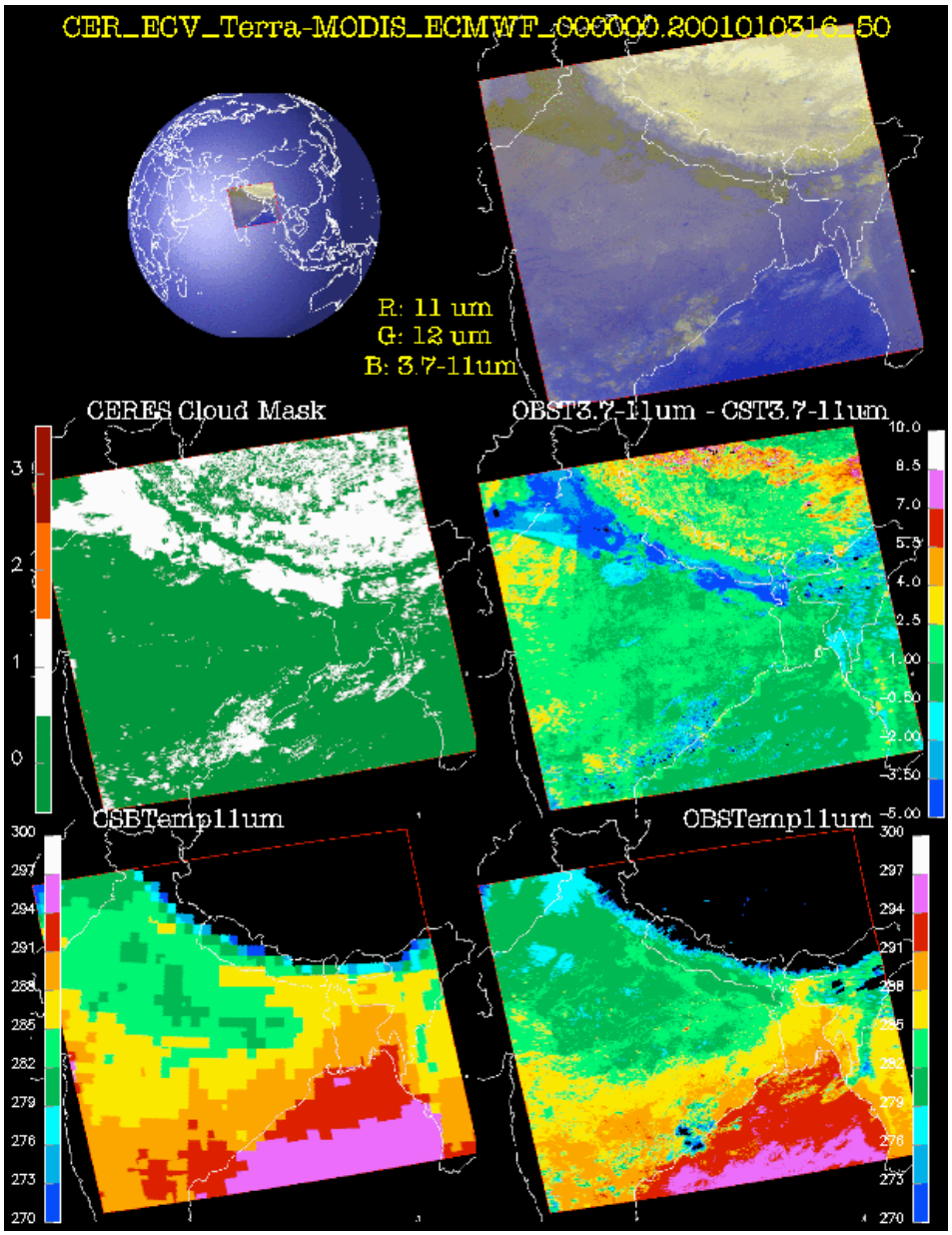
DAO too hot over northern India





EC resolves mountains better

Nobody does Tibet right!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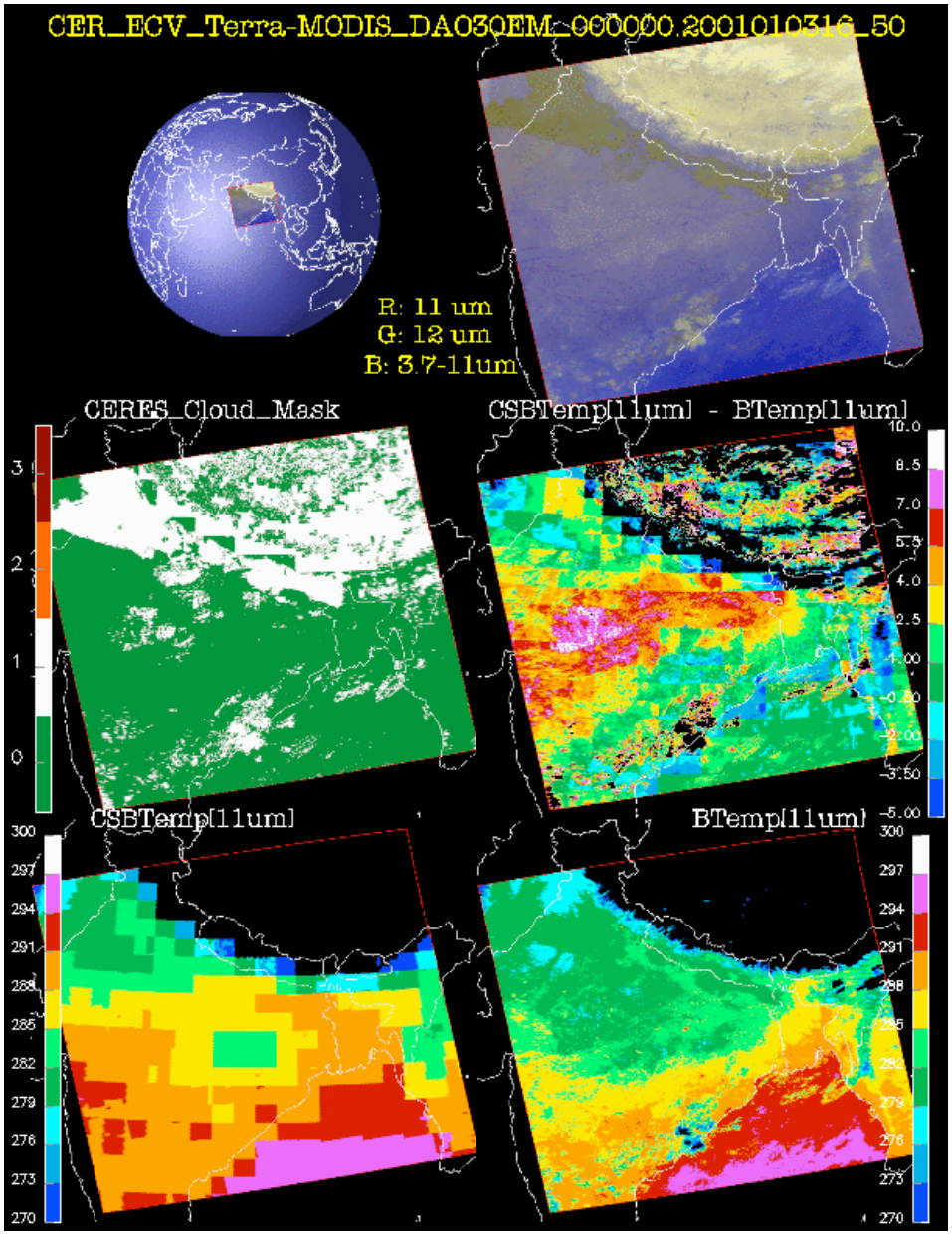
R: 11 um
G: 12 um
B: 3.7-11um
CERES Cloud Mask
OBST3.7-11um - CST3.7-11um
CSBTemp11um
OBSTemp11um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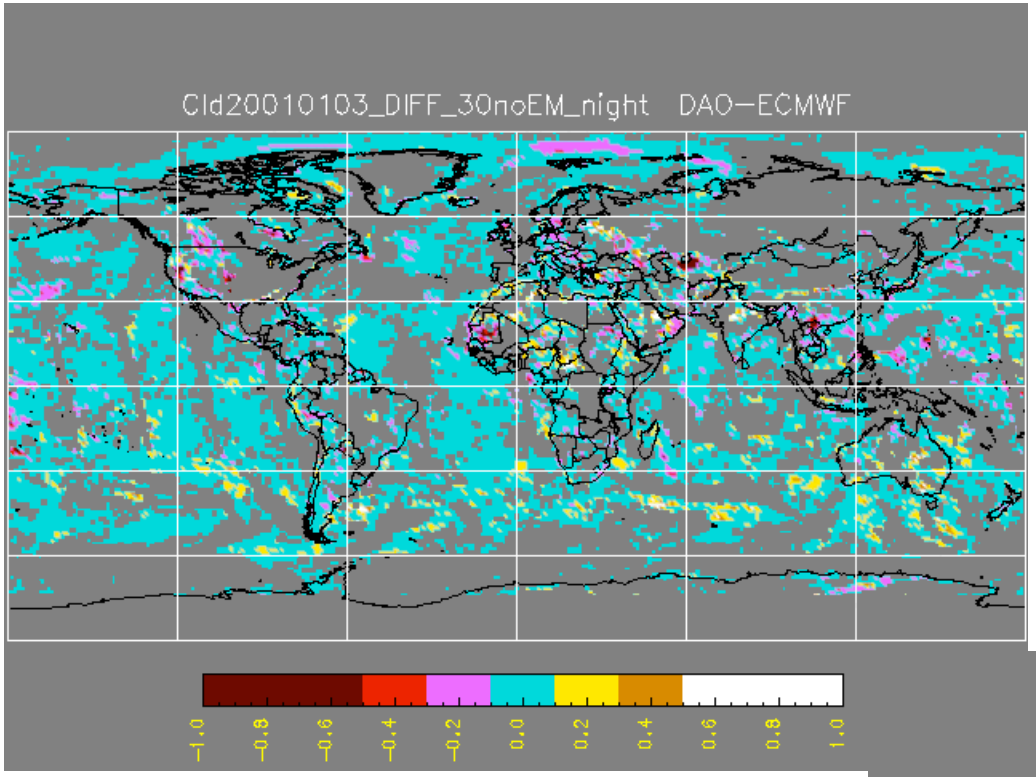
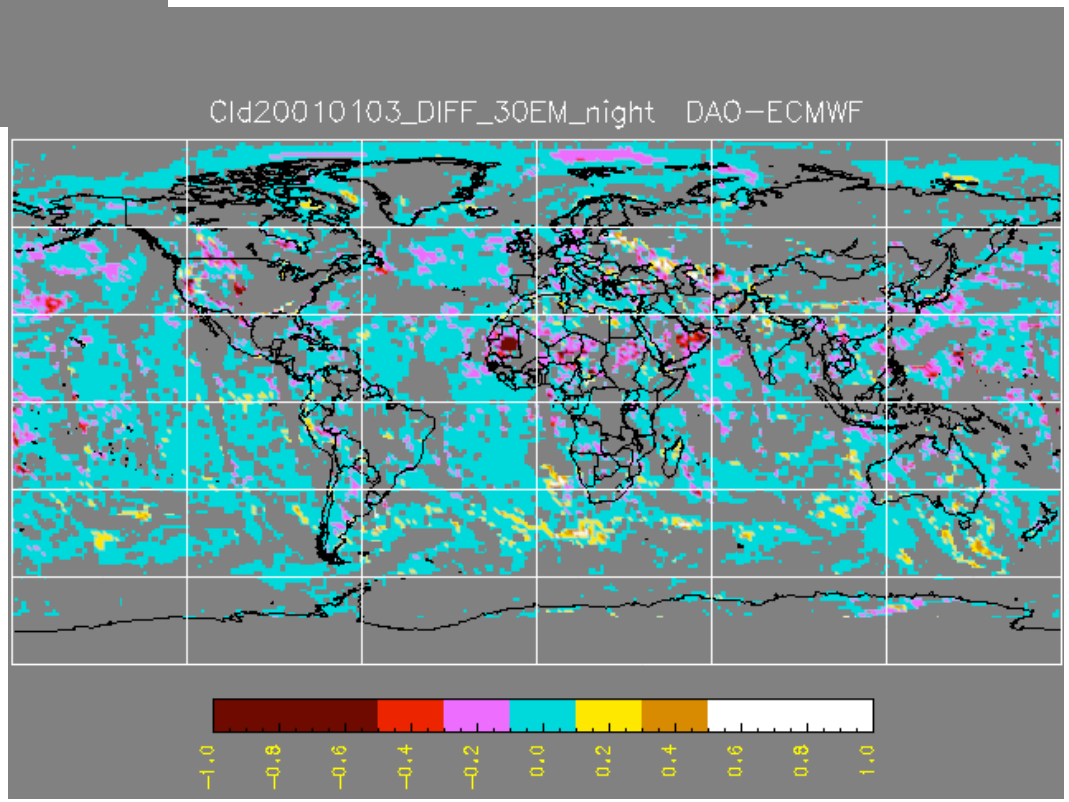
R: 11 um
G: 12 um
B: 3.7-11um
CERES_Cloud_Mask
CSBTemp[11um] - BTemp[11um]
CSBTemp[11um]
BTemp[11um]

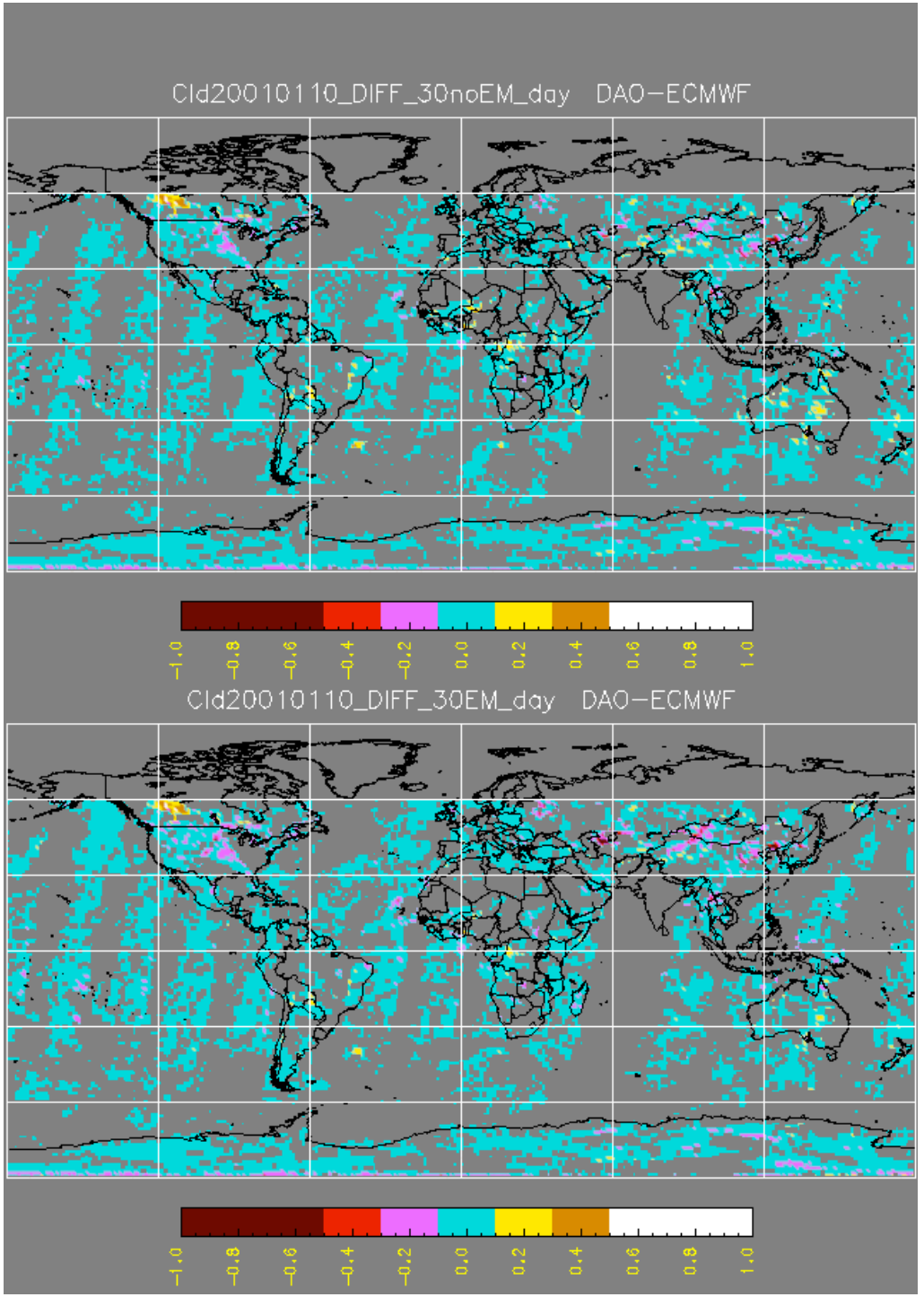


Night
Cloud Amount
Differences 1/10/01



Daytime

Cloud Amount Differences 1/10/01



SUMMARY OF CLOUD AMOUNT DIFFS

	Land		Ocean	
Day	**Non-Polar**	**Polar**	**Non-Polar**	**Polar**
DA	0.003	0.006	0.002	-0.001
D30	-0.002	-0.003	0.002	0.002
D30E	-0.008	-0.003	-0.007	0.002
Night				
DA	0.025	0.008	0.007	-0.006
D30	-0.008	0.008	0.003	0.002
D30E	-0.035	0.010	-0.017	-0.017